Space Weather Technical Forecast

Issued on Thursday 20 March 2025 at 13:07 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout. Chance G1-G2/Minor-Moderate Storms throughout, due to CME arrivals, and later a HSS connection.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M1.5 flare observed at 19/2040 UTC from AR4031 in the northwest quadrant. There are currently ten sunspot regions on the visible disc. AR4028 and AR4031 are the two largest and slightly more magnetically complex regions on the disc, with AR4031 being the most active region over the past 24hrs. AR4026 has re-emerged in the southwest quadrant. Most other regions appear to be relatively small, simple or in decay.

No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, were at elevated to slightly elevated levels, falling from 520 km/s to around 430 km/s. Density was average to slightly above average. Interplanetary Magnetic Field, Bt, was weak, falling from around 8nT down to 4nT, with the north-south component, Bz, also weak, ranging between +5 and -6nT, favouring a negative orientation at first. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp1-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was mostly at background to moderate. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 1.44e7 at 20/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are four CMEs which feature in the forecast in the coming days (20-22 Mar). Solar winds are likely to remain mostly at slow to slightly elevated levels, with elevated enhancements possible due to forecast CME arrivals. Quiet to Active activity expected initially, with a chance of G1-G2/Minor-Moderate storms Days 1-3 (20-22 Mar) should any of the four possible CMEs arrive and/or combine. A further enhancement is possible on Day 4 (23 Mar) due to a high speed stream from CH24/-, which is currently near centre-disc.

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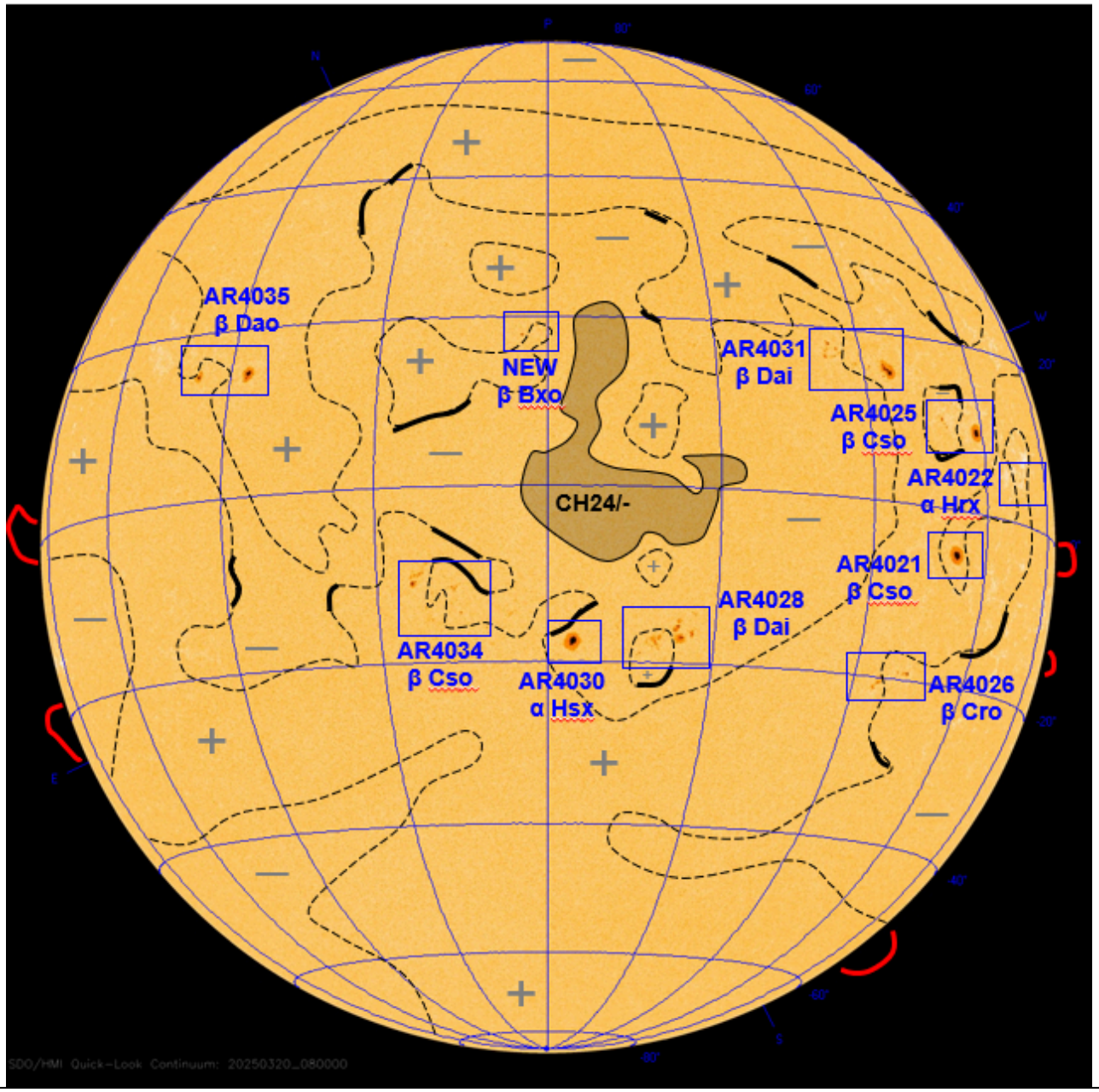
Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at background to moderate levels. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period.

Figure 1: Solar Synoptic Map valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are four CMEs which feature in the forecast.

The first three CMEs all left the Sun on 16 and 17 Mar from various filament eruptions on the Suns surface. The first was initially forecast to arrive on 19 Mar, and may well have missed Earth, although an observed slight enhancement in the magnetic field parameters on 19 Mar may indicate a weak brush past. The second and third CMEs are forecast to give possible glancing blows late on Day 1 (20 Mar) and then early on Day 2 (21 Mar). These are likely to be weak if they do arrive, but any combined effects may give a slightly greater enhancement. EPAM observations showed a rise in low energy protons from 20/0400 UTC onwards, possibly signalling a CME arrival is imminent, although no evidence of a CME arrival has been observed in solar wind data at time of writing.

The fourth CME was observed leaving the Suns NE limb early on 19 Mar, possibly as a result of a filament eruption from the north-centre disc that occurred around 19/0034 UTC. This has been analysed and results in ENLIL suggest a potential glancing blow at Earth late on Day 3 (22 Mar). Confidence in the CME aspect of the geomagnetic forecast is low due to the number of possible CMEs arrivals, and the possibility of one or more combining in transit, or even missing Earth all together.

Solar winds are expected to be generally at slow to slightly elevated levels over the next few days, perhaps rising with any CME arrival. Further enhancement is then likely from CH24/-, currently near centre disc. This is likely to move into a geoeffective location in the western hemisphere in a few days time, with a possible high speed stream arriving at Earth either on Day 3 or 4 (22-23 Mar), with solar winds perhaps reaching elevated levels (500+ km/s).

Geomagnetic activity is expected to be Quiet to Active initially, with a chance of G1-G2/Minor-Moderate storms Days 1-3 (20-22 Mar) should any of the above CMEs arrive and/or combine. This risk increasing slightly into Day 4 (23 Mar) with the CH/HSS connection adding to any ongoing enhancement.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	30	30	30	40
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
17/0253	Partial	Filament Eruption	Northeast	580	19/2100	A large shock associated with this CME. Likely missed.
17/1809	Partial	Filament Eruption	Northwest	600	20/1800	Low confidence on exact timing due to interactions with other CMEs. May combine.
18/0215	Partial	Filament Eruption	Northeast	520	21/0100	Low confidence. Chance of a glance.
19/1121	Partial	Filament Eruption	North-centre	635	22/1900	Glancing blow from shock possible.

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Figure 2: MOSWOC Enlil

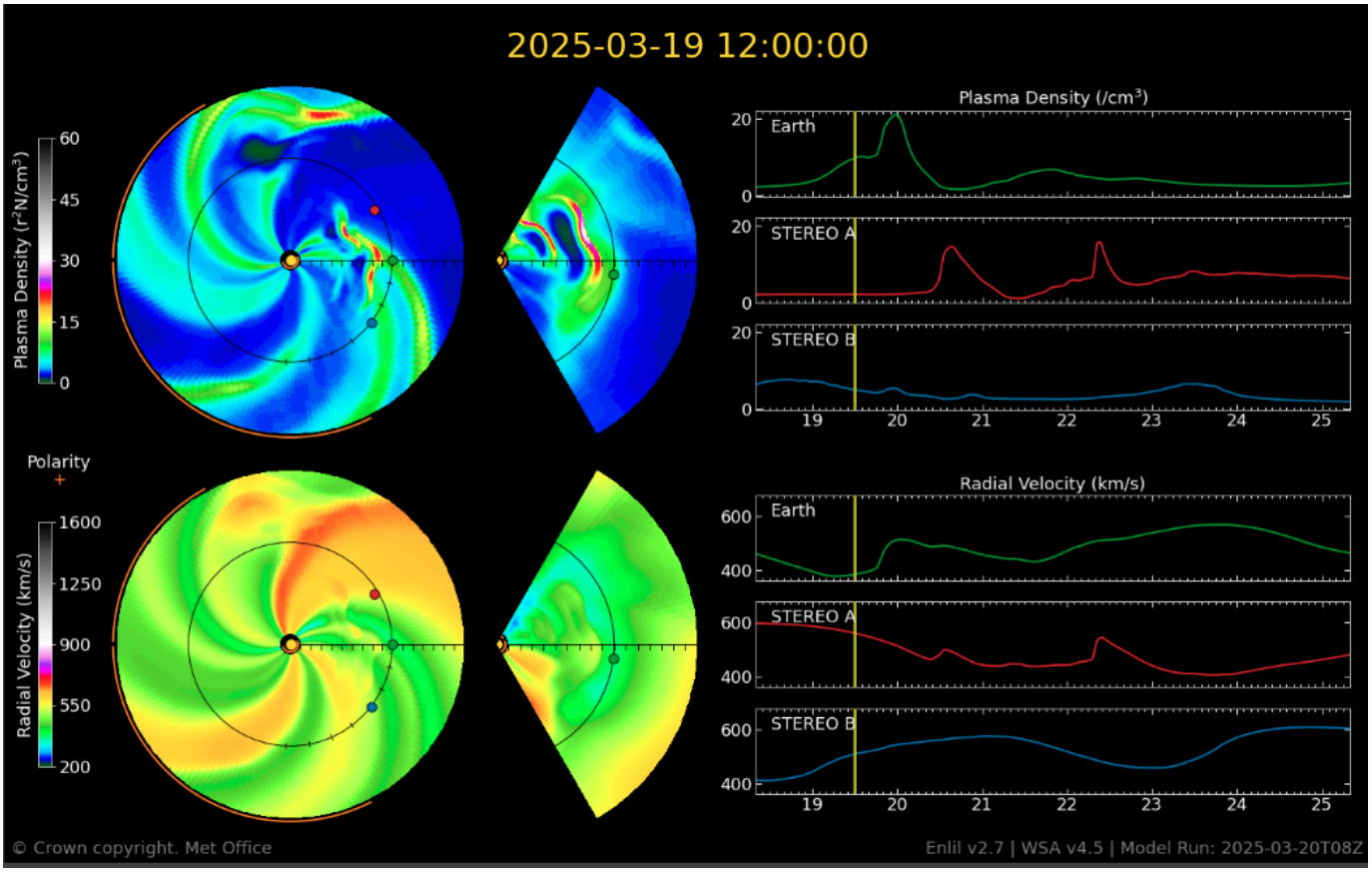

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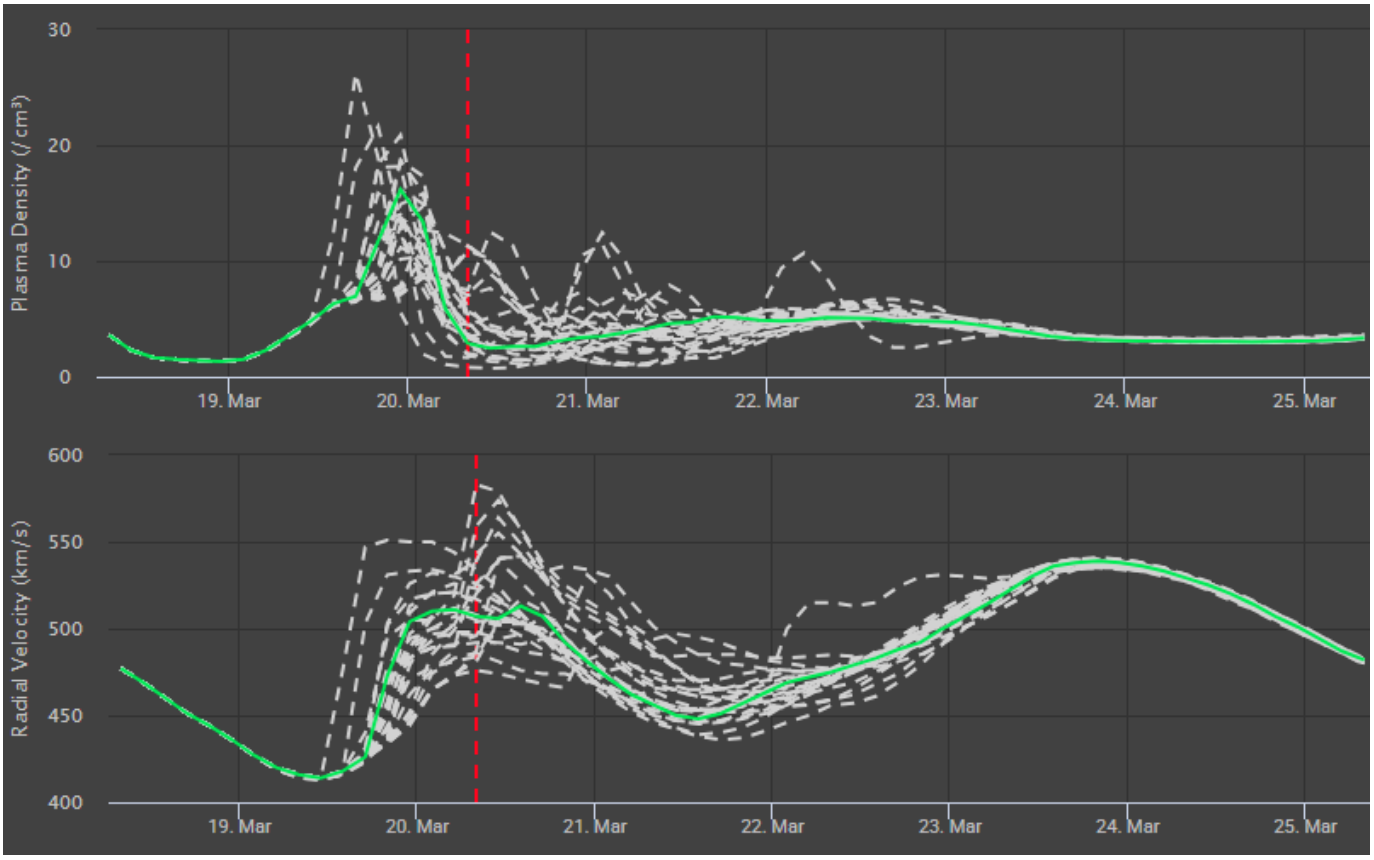
Figure 3: MOSWOC Ensemble model, showing possible spread of CME arrivals, and then connection to CH24/-.



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Radio Blackouts - X-Ray Flares

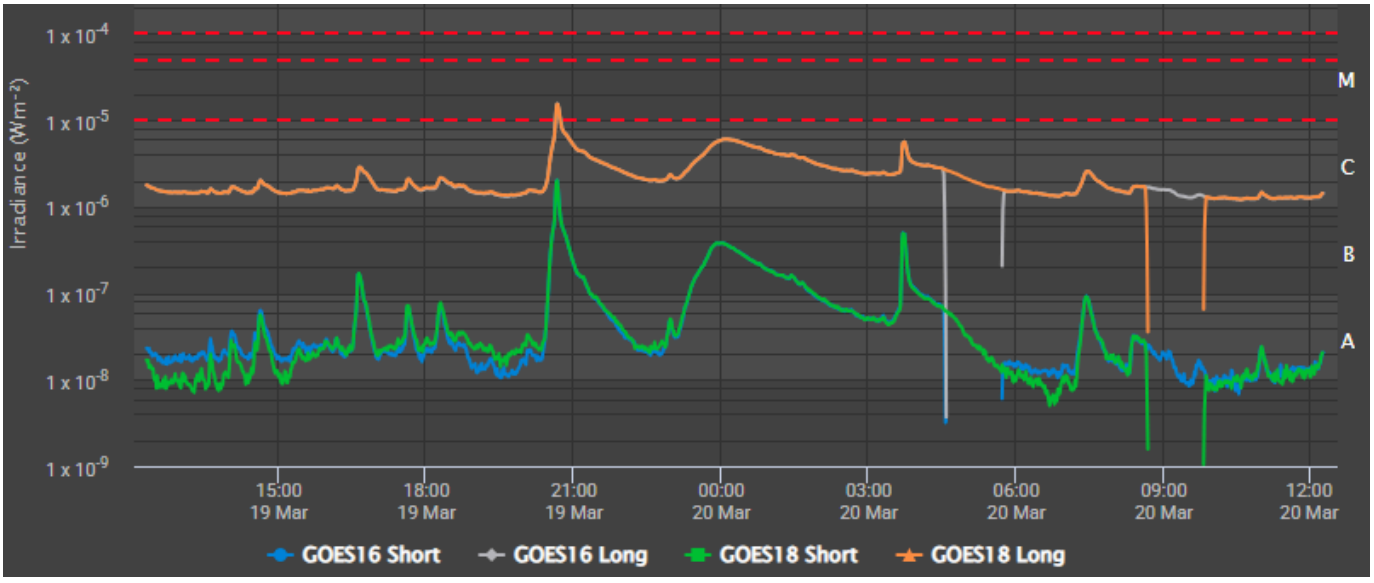
Solar activity has been Moderate, with an M1.5 flare observed at 19/2040 UTC from AR4031 in the northwest quadrant.

There are currently ten sunspot regions on the visible disc. AR4028 and AR4031 are the two largest and slightly more magnetically complex regions on the disc, with AR4031 being the most active region over the past 24hrs. AR4026 has re-emerged in the southwest quadrant. Most other regions appear to be relatively small, simple or in decay.

Low to Moderate activity is expected, with a chance of further isolated M-class flares.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	40	40	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 4: GOES-16 & -18 X-ray flux



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current inactivity and magnetic simplicity of the small regions on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux has fallen from diurnally high levels over recent days, now down at background to moderate. With possible CME arrivals expected over the next few days (20-22 Mar), this may serve to clear some electrons from their orbits, keeping flux at these levels, although prior to, or in the absence of, any CME arrivals electron flux could return briefly to high levels. Confidence is therefore low due to these uncertainties in the CME forecast.

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the remainder of the period, especially with possible CMEs arrivals in the coming days, and is considered reasonable guidance, albeit with low confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: GOES-16 Electron flux

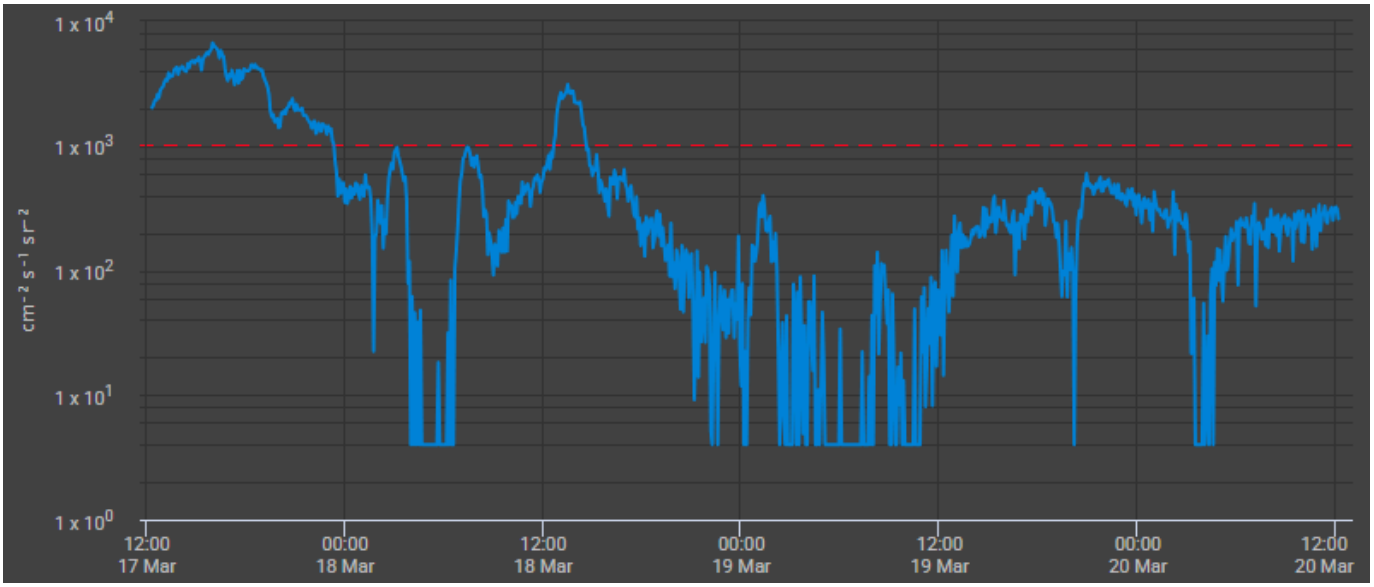

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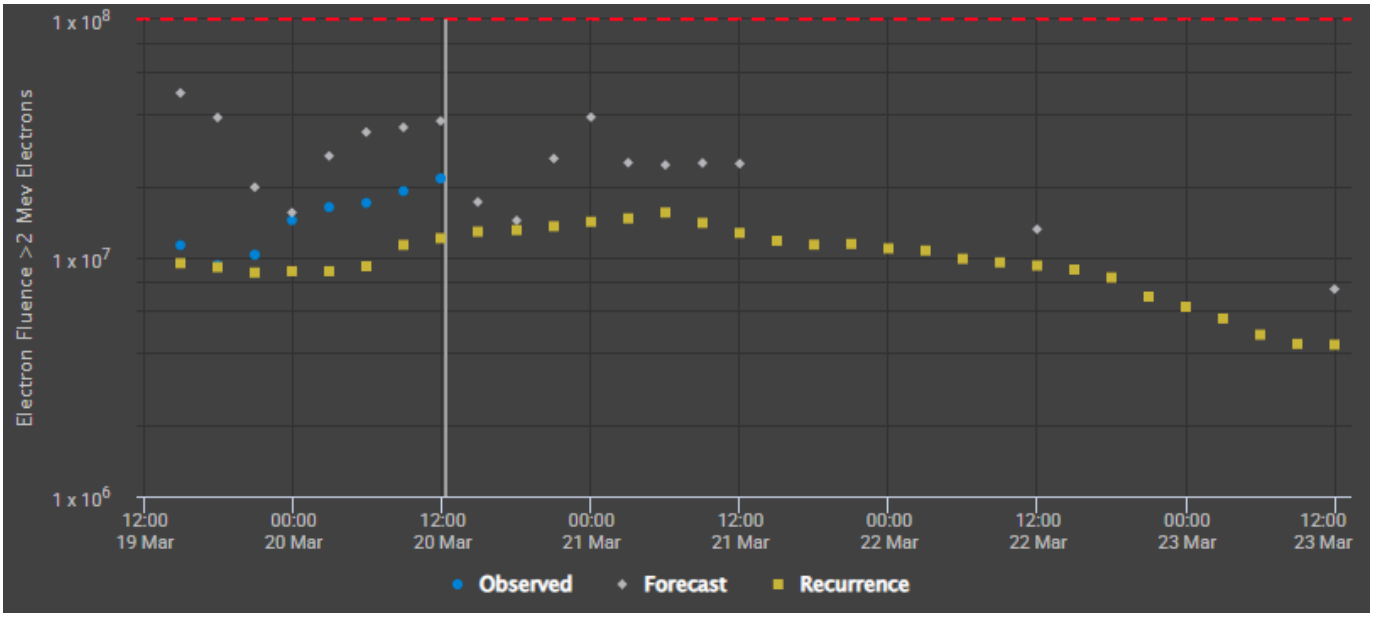
Figure 6: MOSWOC REFM



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